REPORT DOCUMENTATION PAGE

AFRL-SR-BL-TR-01-

0150

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
20/2/2001	Final Report	1/4/99-30/9/00

4. TITLE AND SUBTITLE
Micromechanical Measurements of Foams, Adhesives And Composites (DURIP 99)

5a. CONTRACT NUMBER

5b. GRANT NUMBER
F49620-99-1-0228

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Stelios Kyriakides and Kenneth M. Liechti

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
The University of Texas at
Austin
Austin, TX 78712

8. PERFORMING ORGANIZATION REPOR NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AFOSR/NA
801 N. Randolph St. Room 732
Arlington, VA 22203-1977

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFOSR)
NOTICE OF TRANSMITTAL DTIC. THIS TECHNICAL REPORT
HAS BEEN REVIEWED AND IS APPROVED FOR PUBLIC RELEASE
LAW AFR 190-12. DISTRIBUTION IS UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
This was an AFOSR DURIP 99 Instrumentation Grant. The grant was used to purchase two major pieces of equipment and to design and fabricate two others. The equipment are being used t perform micromechanical testing and image processing in fiber polymeric foams and honeycomb adhesives and composites. The first piece of equipment purchased is an M-5 Atomic Force Microscope from ThermoMicrosopes. The facility is being used for general surface scanning and for custom material testing. An Optronics digital camera and a digital video disk recorder were purchased for general monitoring of material testing. A 15 ft drop weight testing facility along with related accessories was designed, fabricated and tested during the period of the grant. The facility is being used to establish the dynamic energy absorption capacity of honeycombs and other light weight materials. A Mixed-Mode Delaminati Tester was designed and fabricated for examining interfacial and near interfacial crack growth in composites. The facilities have become part of the laboratory of the Center for Mechanics of Solids Structures & Materials of the University of Texas.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERS
a. REPORT	b. ABSTRACT	c. THIS PAGE			S. Kyriakides
None	None	None	None	4	19b. TELEPHONE NUMBER (include ar code) (512) 471-5963

MICROMECHANICAL MEASUREMENTS IN FOAMS, ADHESIVES AND COMPOSITES

Final Report for DURIP 99
Grant No. F49620-99-1-0228

by

Stelios Kyriakides and Kenneth M. Liechti

Center for Mechanics of Solids, Structures & Materials
WRW 110
The University of Texas at Austin
Austin, TX 78712

February 2001

FORWARD

This DURIP 99 grant from the AFOSR was aimed to develop some new capabilities in the laboratories of the Center for Mechanics of Solids, Structures and Materials of the University of Texas at Austin. The grant was used to purchase two state of the art pieces of equipment and to design and fabricate two others. The new facilities which are briefly described below will enable the co-investigators to perform micromechanical testing and image processing in fiber polymeric foams, adhesives and composites. These are subjects of ongoing research at their Center funded by AFOSR and other DOD agencies.

EQUIPMENT PURCHASED/DEVELOPED

1. Atomic Force Microscope

An M-5 AFM was purchased from ThermoMicroscopes. The instrument has been housed in a specially modified clean room dedicated to microscopy. It is currently being used for high resolution surface roughness analysis and three-dimensional surface relief mapping with manometer resolution. A second major use under development involves use of the AFM with a suitably designed probe to conduct tensile tests on miniature specimens of lengths of the order of 50 μm. Such size tests are necessary for the analysis of carbon and glass fibers as well as for establishing the in situ properties of ligaments from polymeric foams. This is a novel application of this versatile device which could open up a whole new avenue in materials testing. Extending the use of AFMs to such applications is expected to be a significant breakthrough in mechanical

characterization at the microscale. ThermoMicroscopes has agreed to assist the two PIs in designing new probes suitable for this new application of the instrument.

2. Video Camera and Recorder

An Optronics digital camera was purchased. The camera provides 768 x 494 pixel resolution. Shutter speeds range from 1/10000 to 4 seconds. The recorder is a digital video disk recorder. It can record at 780 x 480 pixels every 0.07 seconds. It accepts a variety of video input signals and can do time lapse recording.

3. Mixed-Mode Delamination Tester

A mixed-mode delamination tester was fabricated for examining interfacial or near interfacial crack growth in composites. The device makes use of piezo-electric actuators to provide displacements in the micrometer range. The displacements are provided normal and tangential to the interface of bimaterial specimens. The loads that can be accommodated in each direction are 1000 lbs. Special flexures are used to provide flexibility in one direction and rigidity in an orthogonal direction. The device was fabricated in the College of Engineering machine shop. The piezo actuators are controlled via a PC using measured displacements across and tangential to the interface.

4. Drop-Weight Testing Facility

One of the PIs (Kyriakides) is working on understanding the energy absorption capacities of foams and honeycombs. Until recently this has involved quasi-static experiments carried out in standard testing machines coupled with complex numerical simulations using implicit and explicit numerical algorithm. In many application of impact mitigation, the dynamical behavior of such materials must also be understood. The original intention was to purchase new drop-weight testing facility capable of performing moderate velocity impact tests. The cost of commercially available facilities of this type was prohibitive while their capabilities was not optimal or flexible enough for the applications. For this reason a custom drop-weight facility was designed and fabricated by the PI and a graduate student. It consists of a three-rail system which guides a yoke on which the weights are attached. Weights of 70 to 500 lb. can be dropped form as high as has a 12 ft. Targets of

10 inches in diameter can be impacted. The impact force is derived from an accelerometer and the velocity from a non-contact fiber-optic displacement transducer. A high speed data acquisition system (National Instruments) is used to monitor the experiments. Special extension of the laboratory including safety precautions was made in order to accommodate installation and operation the new facility.